CSCI 699: Machine Learning in Healthcare and Biomedicine

Units: 4
Spring 2024

Location: GFS 221

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Course Description

This course provides a unique opportunity to explore how machine learning reshapes the landscape of healthcare and biomedicine. With vast volumes of healthcare data and the increasing complexity of medical challenges, the fusion of machine learning and healthcare has never been more pertinent, offering an exciting opportunity to enhance patient care, accelerate drug discovery, and unlock a deeper understanding of human health. This is a pivotal moment where machine learning algorithms and data-driven insights are paving the way for a brighter and healthier future.

This course is intended for students who possess a foundational understanding of machine learning concepts and are enthusiastic about tackling significant healthcare and biomedical challenges. In this course, we will dissect machine learning applications in the streamline of drug discovery, clinical trials, disease diagnosis, and precision medicine. Through analyzing cutting-edge studies, expert guest lecturers, and working on a team project, students will develop a comprehensive understanding of how machine learning is transforming healthcare and biomedicine.

Learning Objectives and Outcomes

Students will get a comprehensive understanding about current computational challenges in healthcare and biomedicine, along with the design of machine learning algorithms to address these challenges. This course will equip students with the skills to proficiently analyze, review, and present research papers. Furthermore, students will learn how to conduct machine learning research and tackle challenges in the healthcare biomedical domain.

Prerequisite(s): -

Co-Requisite(s): -

Concurrent Enrollment: -

Recommended Preparation: CSCI 567, or DSCI 552, or other graduate-level machine learning course, or familiar with machine learning.

Course Notes

This course will be letter graded. The lecture slides and notes will be posted online.

Technological Proficiency and Hardware/Software Required

Proficiency in translating algorithms into code, typically using Python.

Required Readings and Supplementary Materials

All reading materials will be posted online.

Description and Assessment of Assignments

The workload includes delivering one paper presentation, participating in paper reviews, and completing a project. There is a maxium of 10 bonus points that each student can earn.

- *Paper presentation* (40 points)
    - Each student is expected to deliver two paper presentations. The instructor and TA will grade the presentation by its correctness (40%), clarity (30%), and depth of discussion (30%).
    - *Bonus point A*: the presenter will formulate two brief quiz questions for the class after the presentation. If none of the students provide the correct answer, the presenter will earn 1 bonus point per question. Alternatively, if any student in the audience answer the question correctly, the student will earn the 1 bonus point per question.
    - *Bonus point B*: the presenters on Week 2 will earn 1 bonus point.
- *Project* (60 points)

- *Proposal* (10 points): Each team is expected to provide a 2-page project proposal that includes the problem statement, project objectives, and a review of the current state-of-the-art related work.
- *Final presentation* (20 points): Each team will deliver a project presentation during the last two weeks. The evaluation will consider the presentation's quality in the following categories: problem statement (10%), motivation (10%), related work (10%), methodology (25%), results (30%), and discussion (15%).
- *Final report* (30 points): Each team is expected to submit an 8-page project report (excluding references) following the common machine learning conferences format. The report should include a section detailing the individual contributions of each team member.

Grading Breakdown

Assignment	Points	% of Grade
Paper presentation	40	40
Project proposal	10	10
Project final presentation	20	20
Project final report	30	30
TOTAL	100	100

Grading Scale

Course final grades will be determined using the following scale

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Submission Policy

Assignment will be submitted online following the instructions provided by the instructor.

Grading Timeline

Grades are expected within one week of the due date.

Additional Policies

This is no late day for the class. Each additional day of lateness will lead to a 10% deduction from the grade of the corresponding assignment.

Use of Generative AI in this Course

Generative AI permitted but limited as follows: In this course, you are permitted to use artificial intelligence (AI)-powered programs to help you, but only on assignments that explicitly indicate a permitted use of AI. However:

- You should also be aware that AI text generation tools may present incorrect information, biased responses, and incomplete analyses; thus, their answers may not meet the standards of this course.
- To adhere to our university values, *you must cite any AI-generated material (e.g., text, images, and other content) included or referenced in your work and provide the prompts used to generate the content*. Using an AI tool to generate content without proper attribution will be treated as plagiarism and reported to the Office of Academic Integrity.

Please review the instructions in each assignment for more details on how and when to use AI Generators for your submissions.

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings and Homework	Deliverable/ Due Dates
Week 1	Course introduction; Overview of biomedical AI streamline.	Presentation sign-up	
Week 2	Paper presentations on drug discovery, clinical trials, precision medicine and disease diagnosis.		Presentation sign-up due
Week 3	Drug discovery I: graph-based algorithms		
Week 4	Drug discovery II: structure-based algorithms		
Week 5	Drug discovery III: NLP for drug discovery		Project proposal due
Week 6	Clinical trials I: ML in trial design		
Week 7	Clinical trials II: ML in trial operation		
Week 8	Precision medicine I: genomics and biomarkers		
Week 9	Precision medicine II: personalized treatment and drug repurposing		
Week 10	Precision medicine III: multiomics integration		
Week 11	Disease diagnosis I: imaging data		
Week 12	Disease diagnosis II: EHR data		
Week 13	Disease diagnosis III: wearable device data		
Week 14	Project Presentation		
Week 15	Project Presentation		
FINAL	No final		Project final reports due

Statement on Academic Conduct and Support Systems

Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the

perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Course Content Distribution and Synchronous Session Recordings Policies
USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Students and Disability Accommodations:
USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as

early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.